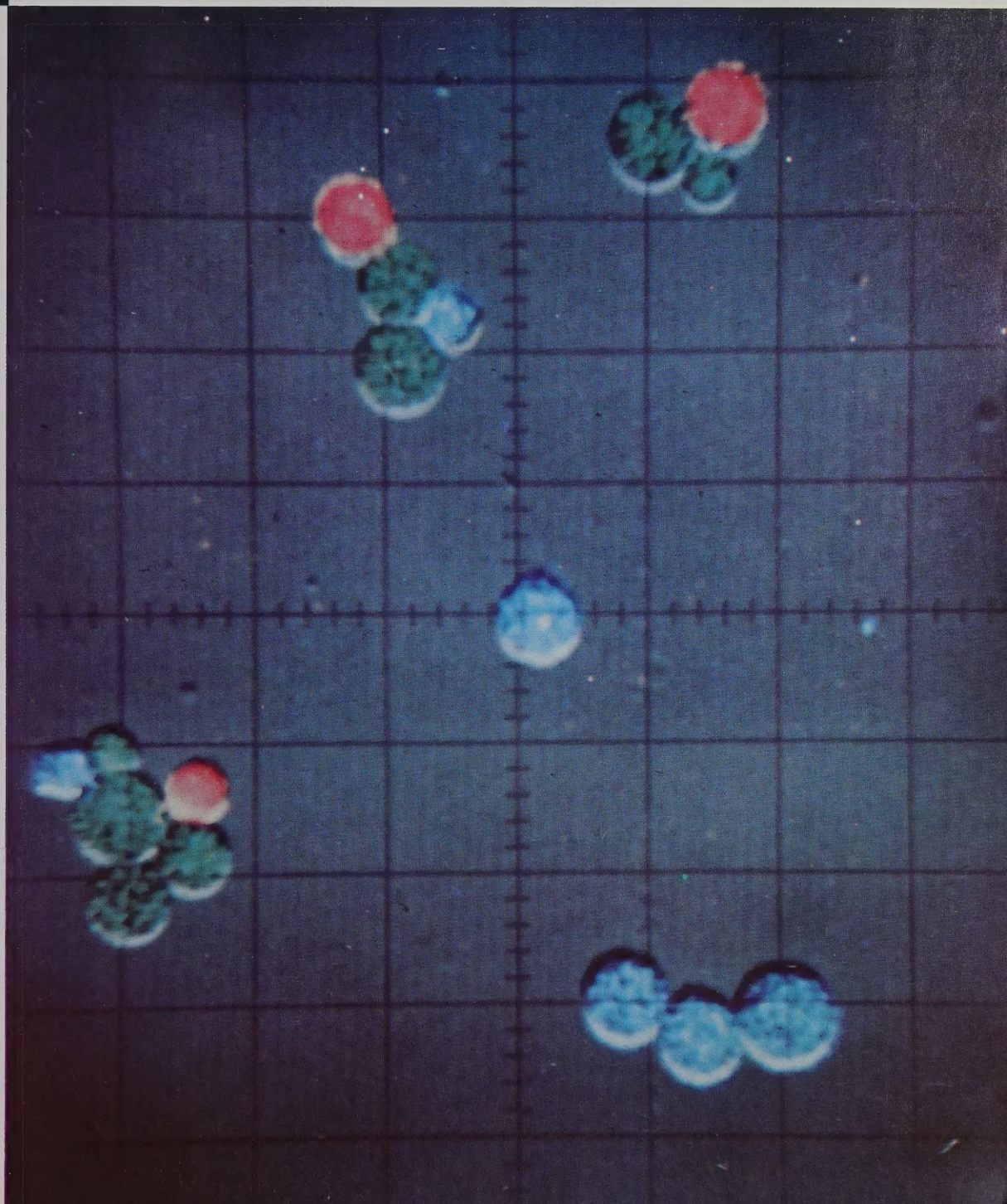
A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

April 1970

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin



UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

APRIL 1970 / VOL. 54, NO. 4 / ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

NATIONAL BUREAU OF STANDARDS
L. M. Branscomb, Director

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FRONT COVER: *Composite of x-ray area scans (X700) of ion exchange microstandard particles uses color to distinguish the element contained in the microstandards—lead (blue), calcium (red), and copper (green). (See page 82.)*

BACK COVER: *The pastel shades in this photomicrograph (X900) of a lunar metal globule reveal its composition in terms of the observed structure. A color separation technique (See Sept. 1969 TNB) developed by H. Yakowitz and K. F. J. Heinrich arbitrarily colors the iron-nickel components pink, the troilite (FeS) at the bottom of the crater yellowish green, and what is probably siliceous ejecta from the crater light blue. This Apollo XI sample is meteoritic in nature and cooled at a rate of 2.5 °C per second on the lunar surface. The globule was probably a metal region in a stony meteorite that was shock melted on impact with the moon.*

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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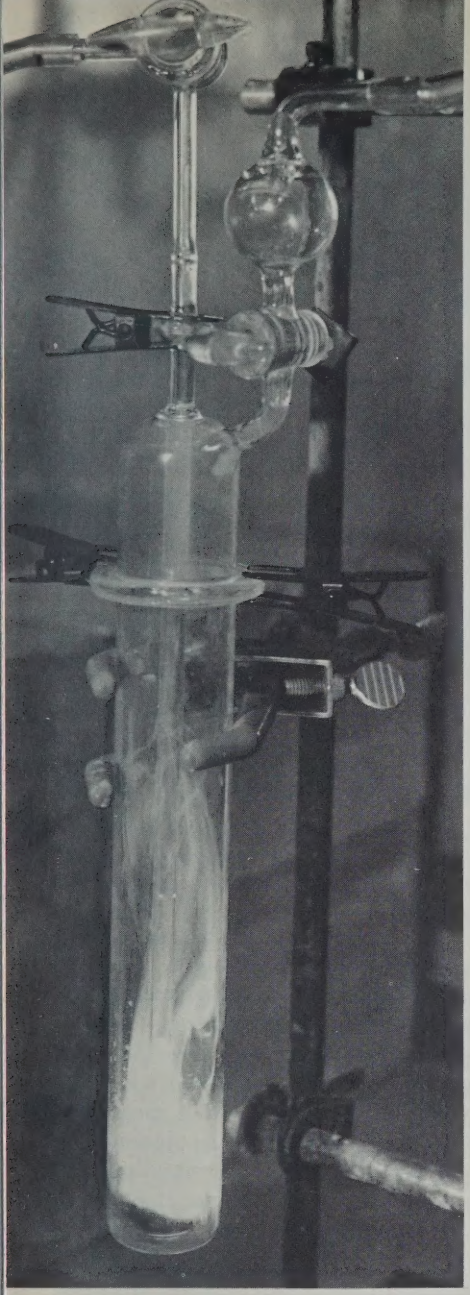


DETERMINATION OF OXYGEN AND CARBON CONTENT OF SODIUM

LIQUID SODIUM IS USEFUL as a heat transfer medium in nuclear power reactors because of its favorable thermodynamic and nuclear properties. These properties include good thermal stability, high boiling temperature, high heat transfer coefficient and fairly low thermal neutron cross section. However, a major disadvantage of sodium is its ability to corrode and carburize structural components with which it comes in contact. Scientists believe that these effects are caused by the trace elements carbon and oxygen. Therefore, reliable analyses for these elements in sodium, at levels of a few parts-per-million, will help better understand the destructive reaction processes.

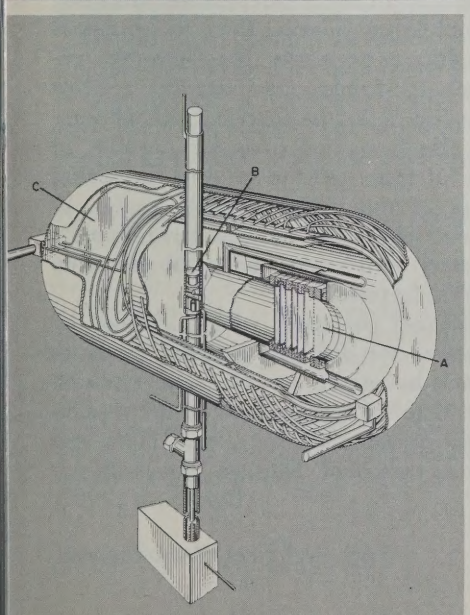
George J. Lutz of the NBS Institute for Materials Research developed techniques [1, 2] utilizing photon activation analysis to determine the oxygen and carbon content of sodium. The method entails bombarding the sodium sample with high energy photons, producing radioactive isotopes of carbon and oxygen. The isotopes are then separated from the sample and the amounts of each isotope are determined.

The NBS electron linear accelerator was used to irradiate the samples. Electrons, accelerated to 35 MeV, impinge on a water-cooled tungsten target, and produce high energy photons (bremsstrahlung) which penetrate the sample. Compressed air rapidly transports the sample, in its aluminum container through an aluminum tube, to and from the irradiation area. This method enables the scientist to rapidly analyze very short-lived radioactive isotopes. Prior to analysis, the sodium is etched in an alcohol-water mixture to remove surface contamination.

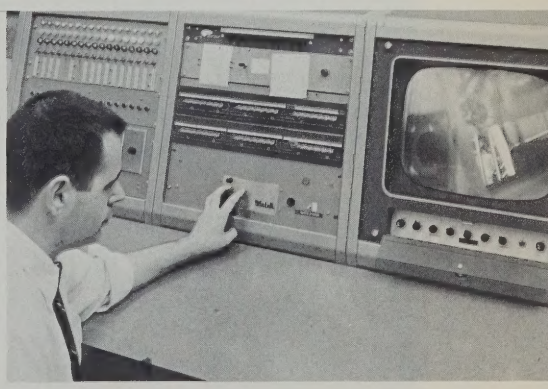
Carbon content is determined by first burning the sodium in oxygen, converting the carbon to sodium carbonate. Adding acid liberates radioactive carbon as carbon dioxide, which is trapped in a sodium hydroxide solution. A gamma scintillation detector then counts the amount of radioactive carbon in the solution.

For determining oxygen content, the sodium is dissolved in water, and the radioactive oxygen exchanges with the oxygen in the water. A portion of the water is distilled from the mixture and the radioactive oxygen is quantitatively detected.

[1] Lutz, G. J., Determination of oxygen in sodium by photon activation analysis, 158th American Chemical Society Meeting, New York, Sept. 7–12, 1969, and Anal. Chem. (in press).
[2] Lutz, G. J., and DeSoete, D. A., Determination of carbon in sodium by photon activation analysis, Anal. Chem. 40, No. 4, 820–822 (April 1968).



Above left: Burning sodium in oxygen converts radioactive carbon to sodium carbonate, which is then treated to release the carbon for quantitative analysis. Left: Sectional view of irradiation chamber in magnet room of NBS LINAC. Electron beam enters from right, penetrates six tungsten plates (A) to produce high-energy photons that irradiate the sodium sample in aluminum container (B). The photon beam is absorbed in a water-cooled beam dump (C). Right: From a TV monitor Larry W. Masters directs technicians in the LINAC's experimental area. The technicians focus the camera on activation analysis apparatus.



FREQUENCY RANGE OF PIEZOELECTRIC ACCELEROMETERS

THE PIEZOELECTRIC ACCELEROMETER is a valuable instrument of today's science and technology, but for accuracy care must be taken to use it only at frequencies below the resonance of the vibrating system. This resonance can be determined by one of two methods: electrically driving the accelerometer and monitoring the displacement, or mechanically driving the entire system while monitoring accelerometer electrical output. In some cases these methods produce different values of resonance, which can lead to unexpected errors if the higher value is taken as the correct one without further checking.

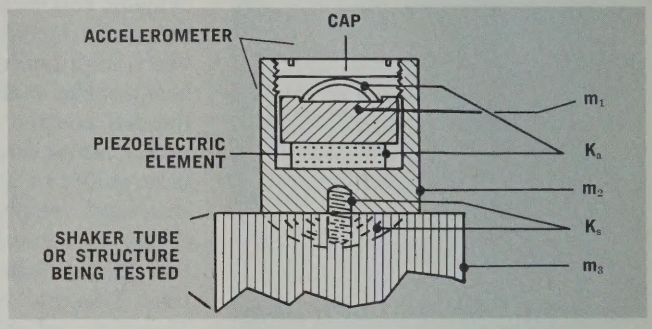
Study of resonant frequency determinations by the electrical and mechanical methods at the Bureau disclosed a major reason for the discrepancies. Nathan Newman, of the NBS Institute for Applied Technology, computed the frequencies by both methods for representative vibrating systems to find when and why this discrepancy occurs. His comparison identifies the parameters which contribute errors and assesses the discrepancy between values, so that users can determine the validity of their resonant frequency measurements.[1]

The electrical response of any piezoelectric accelerometer is flat for a wide range, but climbs rapidly to a peak at resonance, restricting its use to a range below resonance. The frequency of resonance is determined not only by the accelerometer parameters, but also by the characteristics of the structure to which it is attached. For this reason resonances often have to be determined empirically, with the pickup in place on the test piece.

TABLE 1. *Parameter Sets Corresponding to 2 percent and 10 percent Levels of Difference Between Resonant Frequencies Computed for Electrical and Mechanical Excitation*

2 Percent Difference			10 Percent Difference		
$r=k_s/k_a$	$a=m_2/m_1$	$b=m_3/m_1$	$r=k_s/k_a$	$a=m_2/m_1$	$b=m_3/m_1$
16	16	375	16	16	34
—	12	130	—	12	9
—	—	—	—	10	4
—	8	64	—	8	3
—	4	36	—	4	3.4
—	2	30	—	2	3.7
—	1	26	—	1	4.6
4	16	420	4	16	80
—	8	225	—	8	43
—	4	125	—	4	24
—	2	75	—	2	14
—	1	50	—	1	9
1	16	425	1	16	81

Where: k_s is the spring constant of attachment.
k_a is the spring constant of the piezoelectric material.
m_2 is the mass of the accelerometer base.
m_1 is the seismic mass.
m_3 is the mass of the attachment region of the structure.



Upper: Nathan Newman installs a piezoelectric accelerometer on a piezoelectric shaker for determining the system's resonant frequency by two methods. Lower: Typical configuration of a piezoelectric accelerometer.

Users of accelerometers can identify resonance as the frequency at which the displacement of the vibrating system approaches a maximum from both directions, for the method using constant-amplitude sinusoidal electrical input to the pickup. If the mechanical-drive method is used, resonance is indicated by peaking of the piezoelectric output for constant-amplitude sinusoidal acceleration. The former method is more widely used because it is easier to employ, but the user may not be aware of possible discrepancies.

To investigate reasons for the discrepancies, vibrating systems were analyzed by considering them to be masses connected by springlike components. Mr. Newman employed this approach to develop formulas for relative resonant frequencies (ω/ω_0) by the electrical and mechanical drive methods. He computed ω/ω_0 for a series of values for the ratios of mass and the ratio of the spring constants. The mass of the vibrating body region to which the pickup is attached and the spring constant by which the accelerometer base is attached to the vibrating body are included in the factors.

Comparison of resonant frequency values obtained by the two methods showed the disparity between values to be smallest for systems having an attachment region with a much greater mass than the seismic mass of the accelerometer, the base mass greater than the seismic mass, and the attachment spring constant between accelerometer

(*Continued p. 87*)

NO FLUCTUATION IN n-p CROSS SECTION

RECENTLY, HUNGARIAN SCIENTISTS, finding fluctuations in the neutron-proton scattering cross section, suggested [1] the possible need for revising the theory of the interaction occurring between neutrons (n) and protons (p) at MeV energies. Although the conventional theory of n-p scattering is based on basic physical principles, it has been relatively unsupported in detail by experimental data. Therefore, because the new data implied that the fundamental assumptions about nuclear forces were in some way incomplete, it aroused much speculation among scientists.

At the Bureau scientists carried out an experiment to settle the question. The work [2] was performed by R. B. Schwartz, R. A. Schrack, and H. T. Heaton II of the NBS Center for Radiation Research, with support from the Defense Atomic Support Agency of the U.S. Department of Defense. Their conclusion was a verification of the original theory; they found no fluctuations in the n-p scattering cross section.

According to the original theory, the n-p interaction is an elastic collision whose cross section (the probability that an interaction will occur) is shown graphically as a smooth, monotonically decreasing energy function. The Hungarian scientists showed fluctuations of about ± 5 percent at definite intervals of their cross section data, indicating that the n-p interaction was more complicated than previously supposed. Close examination of the NBS data, however, showed no variations "within the statistical precision of ± 0.5 percent." Similar experiments at Harwell, England,[3] and Karlsruhe, Germany,[4] also verified the original theory.

The cross section of n-p scattering was measured in a neutron time-of-flight experiment using the NBS LINAC. In the experiment, accelerated electrons strike a target, producing neutrons at all angles. A narrowly selected beam of these neutrons passes down a defined length of tube, strikes a proton-containing material and then is detected.

The proton-containing sample is polyethylene $(C_2H_4)_n$, and the only interaction of concern is the one in which a neutron strikes a hydrogen nucleus (a proton). Any neutron-carbon interactions are compensated for by repeating the experiment, but replacing the polyethylene with a block of carbon having the same amount of carbon atoms as the polyethylene. The ratio of the number of neutrons detected after passing through the polyethylene to the number of neutrons detected after passing through the carbon sample gives the transmission.

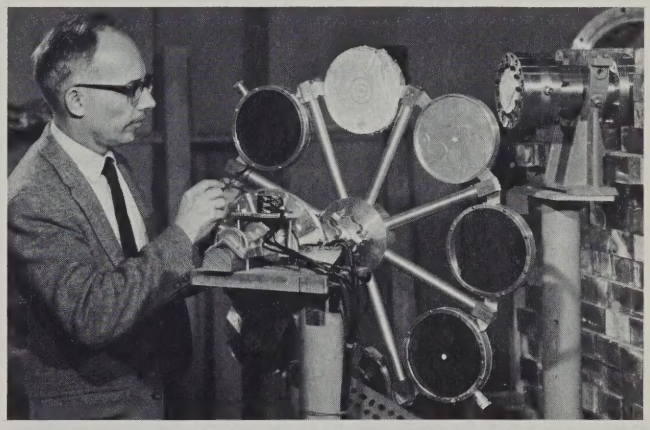
Knowing the transmission and the sample "thickness" (the number of atoms per square centimeter), the cross section can be computed. Plotting the cross section versus neutron energy gives a smoothly decreasing curve with no fluctuations within experimental accuracy.

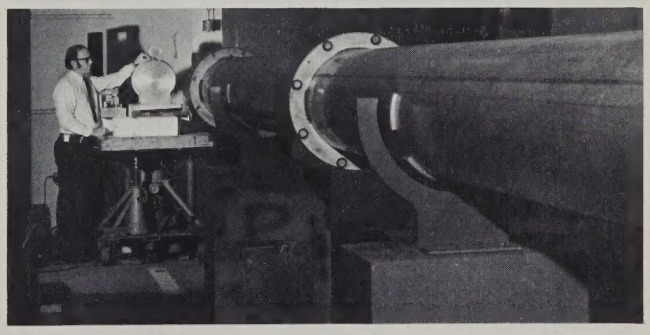
[1] Hrehuss, Gy., and Czibok, T., **Oscillations in the energy dependence of the n-p scattering cross section**, Phys. Letters **28B**, No. 9, 585–587 (Mar. 1969).

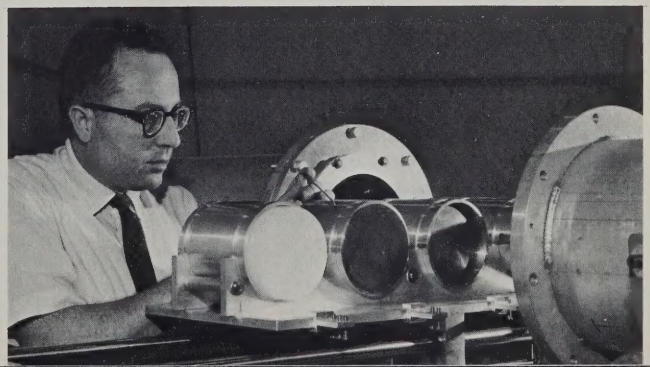
[2] Schwartz, R. B., Schrack, R. A., and Heaton, H. T., II, **A search for structure in the n-p scattering cross section**, Phys. Letters **30B**, No. 1, 36–38 (Sept. 1969).

[3] Clements, P. J., and Langsford, A., **On the monotonic variation of the n-p total cross section with energy in the range 1.0 to 7.9 MeV**, Phys. Letters **30B**, No. 1, 25–26 (Sept. 1969).

[4] Cierjacks, S., Forti, P., Kirouac, G. J., Kopsch, D., Kropp, L., and Nebe, J., **High-precision measurement of the total n-p scattering cross section in the energy range 0.7-32 MeV**, Phys. Rev. Letters **23**, No. 15, 866–868 (Oct. 1969).







Above right: Roald A. Schrack tightens sample holders alined to the electron beam of the NBS LINAC (beam enters at top right). The bulls-eye target alines the electron beam with the rotating samples. Center right: H. T. Heaton connects a grounding wire to a neutron detector alined with the neutron time-of-flight tube (right) during experimental preparations. Right: Robert B. Schwartz adjusts material holders placed in the neutron time-of-flight path (neutrons enter from right). The proton-containing material used in these experiments was a white block of polyethylene (left). A carbon block (center) contains the same number of carbon atoms as the polyethylene and was used as a compensating background.

NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

BOND DISSOCIATION ENERGIES IN SIMPLE MOLECULES

NSRDS–NBS–31, *Bond Dissociation Energies in Simple Molecules* [1] (55 cents, SD Catalog No. C13.48:31), by B. deB. Darwent is the latest published critical compilation in the NSRDS series. Mainly comprised of an extensive table, the compilation reviews bond dissociation energies of simple compounds. All values appearing in the literature between 1962 and 1966, and some selected values appearing between 1956 and 1962, are in the table. Organic compounds are excluded except those containing one carbon atom; the groups >CO and −CN are not considered to be organic.

Many of the bond dissociation energies reported here were recalculated from data appearing in NBS Technical Note 270–3, *Selected Values of Chemical Thermodynamic Properties* [1] ($1.25, SD Catalog No. C13.46:270–3), by D. D. Wagman, et al. The bonds are listed alphabetically in the table under the more electropositive elements, except for bonds between H and other elements—these are listed under the other element. Thus, data on O-H, H-Cl, etc., are found under O, Cl, etc. The values are usually quoted at 0 or 298 K and are referred to the gaseous state. They represent the energy required to break a bond at the specified temperature with all substances in the ground vibrational and electronic state. The experimental method for the energy value listed is given and referenced in the table.

The estimated uncertainties of individual measurements are those given by the original authors or reviewers. Recommended values are listed in bold type with estimated uncertainties. Those estimates are based on the extent of agreement between different measurements and on the authors' assessment of the reliability of the various methods. For thermochemically calculated values consideration is given to the precision of each of the thermochemical quantities involved in the calculation. This critical compilation includes a list of 203 references.

TRANSLATION FROM THE SOVIET STANDARD REFERENCE DATA SYSTEM

The first publication of the U.S.S.R. State Service for Provision of Information on Standards (the Soviet equivalent of the U.S. National Standard Reference Data System) was announced earlier (*NBS Technical News Bulletin*, April 1969). This publication and a second one have been translated and published for the U.S. Department of Commerce and the National Science Foundation by the Israel Program for Scientific Translations. Limited copies of these two volumes are available from the NBS Office of Standard Reference Data. The Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151 will soon have them available as TT69-55091 and TT69-55092 respectively for $3 each.

Thermophysical Properties of Gases and Liquids, No. 1 (V. A. Rabinovich, Editor, and A. Moscona, Translator), contains the following papers: Thermodynamic Properties of Carbon Dioxide on Phase Equilibrium Curves; Separation Factors, and Thermal Diffusion Ratios and Constants, Calculated by the Principle of Similarity; Experimental Investigation of the Density of Liquid Hydrocarbons by Hydrostatis Weighing on a Tensometric Balance; Some Forms of the Equation of State for Liquids; Velocity of Sound in Water Vapor; Calculation of the Thermodynamic Properties of Lithium Allowing for Dimerization and Ionization in the Gaseous Phase; Thermodynamic Properties of Solid Mercury at Temperatures Between 0 °K and the Melting Point Under Normal Pressure; Velocity of Sound in Gaseous Ethylene; Equation of State for Berezan Natural Gas; Determination of the Parameters of Similarity Reference Points for Gas Mixtures; The Benedict-Webb-Rubin Equation of State for Gaseous Butylene at Pressures Up to 40 Bars; Basic Thermodynamic Properties and Characteristics of Halogenated Monosilane and Methane; Temperature Dependence of the Viscosity of Rarefied Gases at High Temperatures; Application of the Lennard-Jones (12-6) Intermolecular Potential to the Calculation of the Compressibility, Viscosity, and Thermal Conductivity of Gaseous Butylene; Experimental Investigation of the Viscosity of Gaseous Ethylene and Propylene; Experimental Investigation of the Liquid Vis-

cosity of Propylene, Isobutylene, Butadiene-1,3, Toluol and Cyclohexane; Tables of the Thermodynamic Properties of Carbon Dioxide Over the Near-Critical Range, Methods of Mass Calculation of the Thermochemical Properties of Paraffin Hydrocarbons; Approximate Calculation of the Molar Refractions and Volumes of Compounds of the Form $AR_1 \ldots R_k \ldots$; Tables of the Thermodynamic Properties of Liquid Ammonia; Thermodynamic Properties of Dissociating Hydrogen Peroxide; Generalized Temperature Dependences of the Density of Liquid Alkali Metals.

The Foreword to this volume provides interesting background information on the approach to this and succeeding compilations and critical reviews coming from the Soviet Standard Reference Data System (GSSSD). It is, therefore, quoted below:

> This collection is the first of a series of systematic publications initiated by the GSSSD, designed to supply reliable information on the thermophysical properties of substances and materials and aimed mainly at the practical application of the reference data.
>
> The GSSSD dealing with the fundamental physical constants and properties of substances and materials was established in 1965 by the U.S.S.R. Council of Ministers; its task is to coordinate and direct researches into the properties of substances and materials, involving the derivation, scientific analysis, and dissemination of reliable experimental and calculated data.
>
> A major activity of the GSSSD is the preparation and publication of thematic collections, reference monographs, scientific reviews, and specialized and fundamental handbooks on the properties of substances and materials, which are widely employed in modern technology and are indispensable for the development of new investigations.
>
> The GSSSD publications have been prompted by the profusion of inconsistent reference data issued in many scientific and technical journals, monographs, collections, reports, and newsletters. Quite often the data are simply copied or else show considerable discrepancies. This is due to the rapid evolution of science and technology, the great variety of experimental techniques, and the desire of different researchers to secure more accurate values. One then has to decide between discarding old values in favor of modern ones, adopting a mean value, or just rejecting the new results.
>
> This gives rise to the difficult problem of obtaining reliable reference data, taken to mean the optimal critically selected values of the properties, either experimentally determined or theoretically calculated. Its solution requires introducing standard measurement procedures, and collecting, analyzing and critically evaluating extensive factual material in order to be able to ascertain the best value of the parameter in question and the probable errors involved. It should be borne in mind that any scientific account of experimental investigations is of value only if it gives the relevant characteristics of the tested substance or material, a description of the experimental technique and conditions, the correction factors and the constants used, and an evaluation of the probable measurement error involved. A paper on the theoretical calculation of the properties of substances and materials, on the other hand, should give an analysis of the calculation methods, the establishment of the working formulas, and a comparison of the accuracy of the calculated values against reliable experimental data.
>
> This provides the means of objectively evaluating the given reference data and hence selecting the optimal values for the desired properties.
>
> The work of obtaining reference data on the thermophysical properties of technologically important gases, liquids, and solids has been assigned to the network of GSSSD base organizations—the scientific research institutions of ministries, colleges, departments, and leading enterprises. This undertaking cannot, of course, be effectively carried on in all directions at the moment. There are, however, a number of scientific problems in which it is now possible to start collecting and systematizing reference data on the thermophysical properties of substances and materials. Thus, Soviet scientists are currently taking an active part in implementing the IUPAC (International Union of Pure and Applied Chemistry) program envisaging the compilation of reference tables for the whole practical measurement range of parameters of mono- and diatomic substances, the alkali metals, some hydrocarbons, freons, and several other widely employed substances and materials.
>
> The GSSSD collections are bound not only to promote investigations concerned with obtaining missing data, but also to help collecting, correlating, and evaluating the published data on the properties of substances and materials.
>
> This collection includes papers dealing with the theoretical calculation and experimental determination of the thermophysical characteristics of substances and materials. It also contains some papers devoted to methods of calculation and the derivation of equations of state for pure substances and gas mixtures.
>
> Unlike existing publications, the collection presents the reference data in a form convenient for use; their accuracy is evaluated, and limits are prescribed within which the recommended values may vary. The reliability of the data obtained by theoretical calculation methods is checked against well-tested experimental values or confirmed by the accuracy of the calculation method.
>
> As experience is gained in the preparation of GSSSD publications, the material submitted for print will have to meet higher requirements. These requirements will concern mainly the quality of presentation of the reference material, demonstration of the stated accuracy, thorough analysis, and evaluation of the data. The GSSSD collections will be designed to provide scientific workers, designers, technologists, and planners with reliable information on the thermophysical properties of technologically important gases, liquids, and solids.
>
> Remarks and recommendations on forthcoming GSSSD collections may be addressed to: VNITs SSD (All-Union Scientific Research Center of Standard and Reference Data), 4 Shchusev St., Moscow K-1, U.S.S.R.

Thermophysical Properties of Liquid Air and its Components, by A. A. Vasserman and V. A. Rabinovich is the other publication from the Soviet Standard Reference Data System. This monograph examines the thermophysical properties of liquid nitrogen, oxygen, argon, and air, and is a supplement to the author's previous studies on the thermophysical properties of these substances in the gaseous state. It surveys and analyzes the best-known equations of state for liquids. An equation of state is derived for liquids on the principles of statistical physics, and is deemed valid for many temperatures and densities. The authors develop a method for setting up this equation, which is used to describe analytically the thermal properties of four important cryogenic liquids. The experimental thermal data for liquid oxygen, argon, and air are extrapolated to pressures of 500 bar. As a result, equations of state valid for pressures of practical importance have been established, and the thermal and caloric properties of these

substances have been calculated for parameters that have not been studied experimentally. Values obtained for density were also used in tabulating viscosity and conductivity values of the four liquids with the aid of the limited experimental material on transfer coefficients. Thus it was possible to obtain all the data on the thermodynamic and transport properties of liquid air for the pressures most important for practical applications, extending to the saturation and freezing curves. A bibliography of 270 references is included.

NEUTRON CROSS SECTION DATA

The newest release of the European Nuclear Energy Agency (ENEA) Neutron Data Compilation Centre—Newsletter Bulletin 11, CCDN–NW/11—provides an updated list of the experimental neutron cross sections in its files as of October 1969.

The ENEA Data Compilation Centre at Gif-sur-Yvette, France, was established in 1964 by the Organization for Economic Cooperation and Development as a link between laboratories that produce and those that use neutron cross section data. This center and three associated centers—the National Neutron Cross Section Center at Brookhaven, Long Island, N.Y., the Nuclear Data Unit of the International Atomic Energy Agency, Vienna, Austria, and the U.S.S.R. Nuclear Data Information Center in Obninsk, make up a worldwide network for the storage and supply of these data.

Data can be retrieved from the Centre's files of experimental neutron cross sections on tape, cards, or computer print-outs. Tape copies are available of the main data files and selective literature searches are available from CINDA (Computer Index of Neutron Data). CINDA is an index to all literature on microscopic neutron cross sections. Information on CINDA in the U.S. is available from Lawrence T. Whitehead, Division of Technical Information Extension, U.S. Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tenn. 37830. Persons in OECD countries may obtain information on CINDA from Victor J. Bell, Head, ENEA Neutron Data Compilation Centre, B.P. 9, 91 Gif-sur-Yvette, France.

[1] Order by SD Catalog number from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

LINERBOARD REFERENCE PROGRAM FOR PAPER TESTING LABORATORIES

THE BUREAU HAS INVITED ALL PAPER TESTING LABORATORIES to participate in the FKI Collaborative Reference Program dealing with the bursting strength (mullen) test of linerboard. The program, conducted at the request of the Fourdrinier Kraft Board Institute (FKI), is cosponsored by the Technical Association of the Pulp and Paper Industry (TAPPI) and NBS.

Participation in the program, which is administered by NBS, not only provides a means whereby a laboratory may periodically check the level and uniformity of its testing in comparison with that of other laboratories, but also improves the reliability of test results within and among laboratories. As administrator, NBS prepares and distributes the linerboard samples and provides analyses of test results.

In the paper industry, bursting strength is an important indicator of the strength of paper or paperboard. In the case of linerboard, a paperboard used principally as inner and outer facings for containers, the bursting strength governs the ultimate use of the paperboard. That is, the linerboard must be sufficiently sturdy to resist the tendency of packaged contents to burst open the linerboard or for objects to puncture the linerboard from the outside. In laboratory testing, bursting strength is the pressure required to rupture a circular area of paper 1.2 inches in diameter at a specified rate.

Each laboratory makes 20 pops—or bursts—per week on each of two weights of the linerboard samples. A 4-week supply of randomized sheets is mailed to the participants each month.

After receiving the test data from the laboratories, NBS transfers the data to cards, analyzes them, and reports the results monthly. The report includes averages and various statistical data for all laboratories. Each laboratory, identified only by code number, may readily determine the level and variability of its results in comparison with those of other participating laboratories.

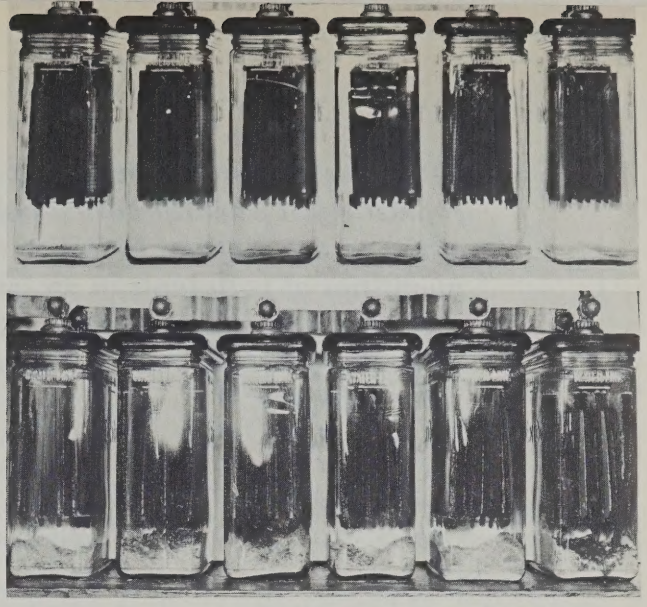
An annual report summarizing the data, the improvement in reliability, if any, and recommended changes in the program, will be prepared by the Bureau and submitted to the participants after the program's anniversary date each year.

Further information on the FKI Program may be obtained from Dr. T. W. Lashof, Administrator, FKI Collaborative Reference Program, National Bureau of Standards, Washington, D.C. 20234.

NOTE: In addition to the linerboard reference program, NBS administers testing programs on such products as vulcanized rubber, paper, bituminous asphalt, concrete, and cement. NBS collaboration with private, industrial, and government testing laboratories in these programs provides a basis for improved quality control.

BATTERY ADDITIVE—

findings of an in-house field experiment



In July of 1953 six lead-acid batteries used as part of the d-c power supply at NBS were randomly selected for inclusion in a test of a battery additive (top). Three of the cells were treated with the additive, three were not, and all six were placed back in routine service. After 10.5 years the treated cells (second, third and sixth, left to right bottom) showed more deposit and their averaged electrical capacity was but 3.5 percent of the untreated cells.

In the Summer of 1953, at the request of the committee appointed by the National Academy of Sciences [1] to look into the work of NBS on a battery additive, the Bureau initiated a special test. This test was designed to ascertain if the additive, as claimed, was effective in reducing or eliminating the sediment or "battery mud" which collects, during operation, on the bottom of lead-acid batteries. A group of six stationary lead-acid cells of the glass-jar type, which were a part of the batteries used by the Bureau as d-c supply for the testing of electrical instruments and for other purposes, was used in the test. These cells had been in continuous operation for 10 years and each contained a small amount of sediment. Three cells were treated with the additive, and three were left untreated as controls. All six cells were photographed at the time of treatment and then returned to service. Photographs taken about 1 month later and compared with the earlier photographs failed to show any measureable difference in the sediment level for any of the cells. The treated batteries continued to be used in an identical manner with the untreated batteries as part of the d-c power supply.

Visual inspection of the cells at periodic intervals over succeeding years showed that the additive, instead of eliminating the sediment, enhanced its formation, accompanied by a decrease in electrical capacity of the cells. Comparison of a photograph taken after 10.5 years with that taken immediately after treatment clearly showed that the amount of sediment formed in the treated cells was greater than in the untreated ones. Determinations of the electrical capacity of each cell were made after 5.5 and 10.5 years of service. It is evident from the results (table 1) that the additive produced a decrease in battery capacity that became very marked after 10.5 years. At the end of 5.5 years the average electrical capacity of the three treated cells was 86 percent, and after 10.5 years, 3.5 percent of that of the three untreated cells. In a second group of four cells, two of which were treated and two left untreated, the sediment likewise increased during cell operation but at such a rate that little electrical capacity was left in either treated or untreated cells after 5 years.

The early tests of the Bureau had been questioned on the grounds that they were laboratory tests and that the merits of the additive could be established only in the field. Here, indeed, was such a field test covering a 10.5-year period, the results of which convincingly confirmed the findings of the laboratory tests.

Table 1

Electrical tests after 5.5 years

106.4 Ampere Hours of Charge Discharged 1/7/59 at 14 Amperes to a Cut-Off Voltage of 1.75

	Treated cells			Untreated cells		
Cell No.	2	3	6	1	4	5
Minutes of discharge	181.2	175.8	193.2	215.1	224.0	198.3
Average minutes		183.4			212.5	

Ratio: $\frac{\text{Average Minutes for Untreated Cells}}{\text{Average Minutes for Treated Cells}} = \frac{212.5 \text{ Minutes}}{183.4 \text{ Minutes}} = 1.16$

Electrical tests after 10.5 years

163 Ampere Hours of Charge Discharged 12/18/63 at 14 Amperes to a Cut-Off Voltage of 1.75

	Treated cells			Untreated cells		
Cell No.	2	3	6	1	4	5
Minutes of discharge	13.0	5.0	3.0	223	175	200
Average minutes		7.0			199	

Ratio: $\frac{\text{Average Minutes for Untreated Cells}}{\text{Average Minutes for Treated Cells}} = \frac{199 \text{ Minutes}}{7 \text{ minutes}} = 28.4$

[1] Report of the Committee on Battery Additives of the National Academy of Sciences, Oct. 30, 1953.

"This advance in measurement science illustrates the way sophisticated scientific work helps solve major problems affecting our Nation. Inability to measure accurately the minute quantities of pollutants in air and water is a tremendous obstacle in all anti-pollution efforts. This significant step along this road will help make both research and regulation easier and more effective."

LEWIS M. BRANSCOMB
Director, National Bureau of Standards

ION EXCHANGE BEADS

the "Micromini" Calibrators

MICROENCAPSULATION TECHNIQUES DEVELOPED AT THE NBS Institute for Materials Research use spherical ion exchange beads to provide a new type of chemical microstandard, permitting accurate sampling of unweighable amounts of chemical substances. For example, direct calibrations have been made with as little as 4×10^{-11} gram of sodium on beads especially prepared to contain sodium. Developed by David H. Freeman [1] and coworkers at the Institute's Analytical Chemistry Division, these microstandards have extended the ability to calibrate mass spectrometers and should be of broad utility in all areas where calibration is needed for instruments that measure extremely small quantities of matter, such as particles found in samples of polluted air and water.

The new use of ion exchange beads is widely applicable to a variety of problems that frequently recur in microanalysis. In the past 6 years, analytical instruments have become so sensitive that providing a small enough calibration sample for test purposes was becoming increasingly difficult. For example, modern multistage mass spectrometers can easily detect 10^{-15} gram of an element, the same as 3 million atoms at mass 200, but there have been no direct ways to provide a known sample of that size. The technique of using single ion exhange beads is so powerful that no lower mass limit has yet been demonstrated.

The use of an ion exchange bead as a microstandard is based upon the fact that these small ion exchange beads* are usually spherical and, for that reason, they can be "weighed" by measuring their diameter with a microscope. A single bead that is 0.010 mm in diameter can thus be measured for mass (1/1 000 000 000 gram) within a tolerance of ± 3 percent. Under "clean room" conditions, a single bead is measured and then transferred to the input receptacle of the instrument to be calibrated.

To obtain the microstandards, several new approaches to traditional ion exchange preparation had to be developed. To illustrate, a special preparation of highly homogeneous exchange beads were developed by the NBS workers. These beads are converted into microstandards by chemical exchange reactions that introduce the required elements as ions which then occupy the interior of each bead. Special procedures are then used to completely prevent any further ion exchange from taking place. The clustered beads are dispersed ultrasonically, and spread by casting on a microscope slide for subsequent measurements of individual beads.

A single bead is identified in the microscope and its diameter is measured. The mass, m_j, of a particular element, j, contained by the bead is calculated from the equation, $m_j = \rho_j v$, where ρ_j is measured in the laboratory and refers to the partial density for the j element.

The proof that the beads are homogeneous is essential to the present concept in which they perform as micro-

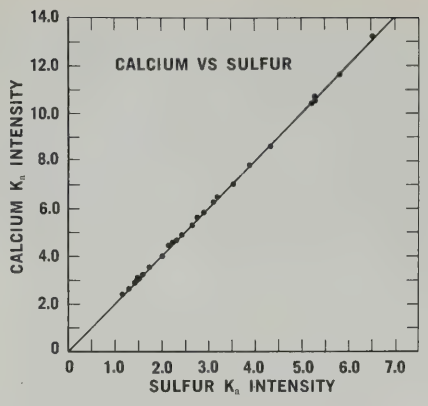
*Homogeneously sulfonated derivative of the copolymer of styrene and divinylbenzene.

standards. By homogeneity is meant that the value of ρ_J is the same for each individual bead within measured, and necessarily small, tolerances. This has been tested in three ways. First, delicate measurement of bead densities in a Linderstrom Lang density gradient tube showed that the bead densities fell within the desired narrow limits. Secondly, the beads were irradiated in the NBS nuclear reactor and the radioactive contents of individual beads were subsequently measured. Finally, electron microprobe analysis indicated nearly constant ratios of elements within the beads.

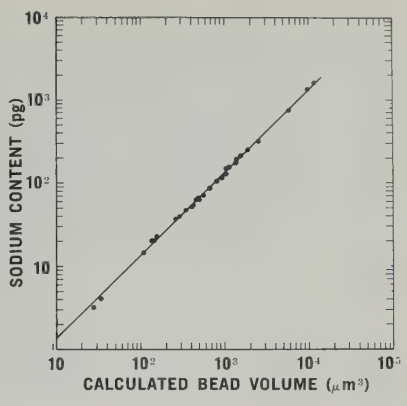
The fact that no lower mass limit has yet been reached for the ion exchange beads suggests the distinct possibility of providing the means of calibrating a wide variety of chemical measurement systems at their most sensitive detection limits. For example, in mass spectrometry, the state of the art has advanced to the point that it is now feasible to analyze samples as small as 10^{-12} to 10^{-14} gram. This is made possible by the development of multistage instruments, very fast ion counting techniques, and the availability of small digital computers by which the spectrometer is controlled and by which the very large amount of data received is processed so that the analysis is quantitative.

The spectroscopist must be able to add to his sample a precisely characterized quantity of the element of interest that is approximately the same weight as originally contained in the sample. The NBS Analytical Mass Spectroscopy Section has used the NBS microchemical standards to analyze quantitatively several elements contained at the ppm level in a single 1 μg particle taken from a glass sample. With the future availability of microstandards containing various chemical elements it will be possible to use these calibration methods for a wide spectrum of measurement problems that occur with organic, inorganic, and biological materials.

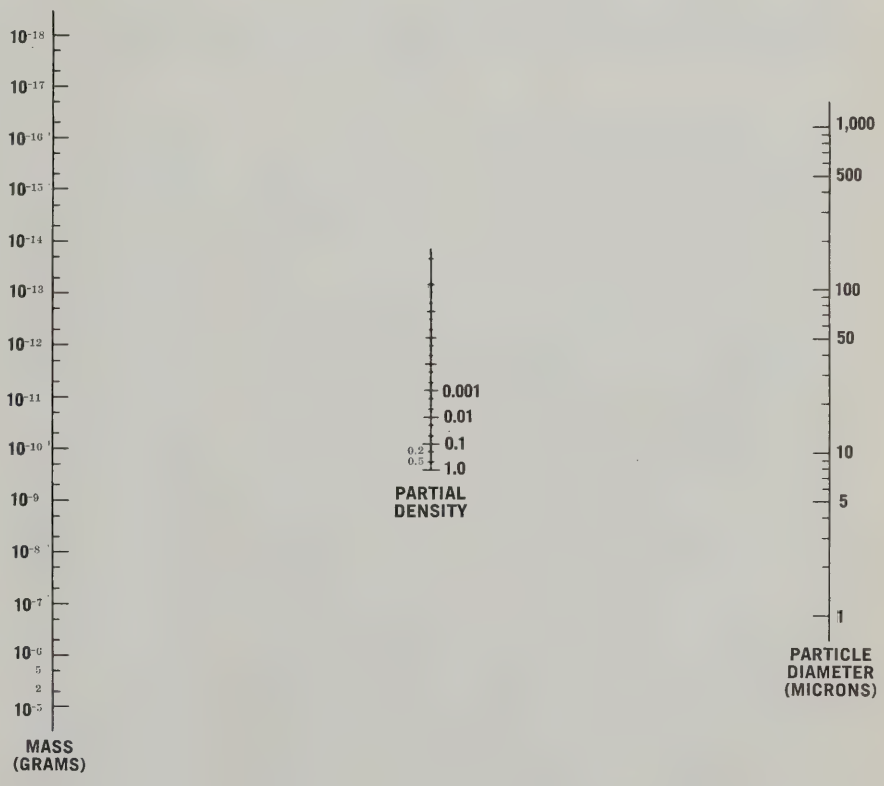
Another area where ion exchange beads offer calibration advantages is



The simultaneous measurement by electron microprobe of calcium and sulfur on single ion exchange beads is shown. The results illustrate the potential for using sulfur, covalently bound to the ion exchange network, as an internal standard. Further, the consistency of the results provide evidence that accidental loss of ions from the bead surface is slight.

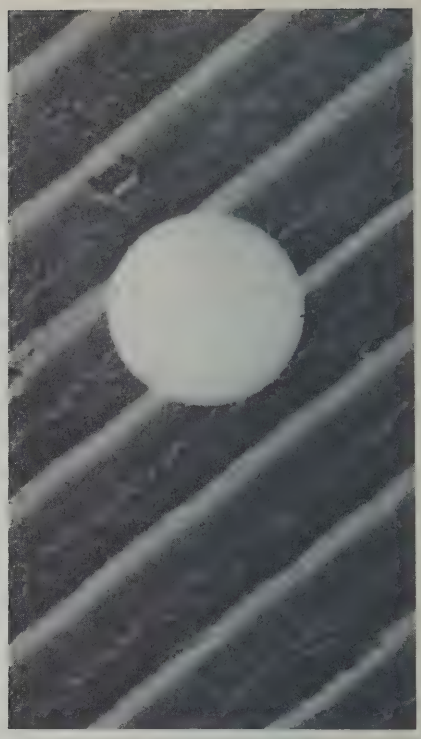


The sodium content of individual ion exchange beads, measured by neutron activation analysis, is plotted against the bead volume as calculated from the microscopically measured bead diameter. The results indicate the wide mass range over which single beads are quantitatively useful as counterion carriers.



Nomogram for determining mass of counterion as a function of particle size and of ρ_J, the specific counterion density (grams/millimeter).

Two-dimensional dispersion techniques are used to isolate single microstandard ion exchange beads: nine such beads are visible in this photomicrograph. (125 ×)



Electron micrograph of 1.3 μm copolymer bead indicates the high degree of sphericity of very small particles.

radioactivity. One application of the techniques developed by NBS was the use of ion exchange beads as microsources of radioactivity. This work was done by Paul Hahn at the Northeastern Radiological Health Laboratory, Winchester, Mass. In this work, ion exchange beads were loaded with radioactive isotopes, and then dispersed ultrasonically. The dispersed beads were spread on photographic (autoradiographic) emulsions, which could then be calibrated for their exposure response to low levels of known particle radioactivity.

Ion exchange microstandards have also been prepared for public availability through the Office of Standard Reference Materials. Calcium, copper, sodium, and lead have been developed as dispersed particle standards in the 10^{-9} to 10^{-11} gram region. These are the first of a series of preparations that are being made available from the NBS Office of Standard Reference Materials.[2]

Future plans will include the preparation of larger standards—up to 1 μg in size. Research efforts are being directed toward the characterization of various mixtures of elements. In this connection a survey is being made for new possible applications such as providing microstandards for specific use in the study of air-borne or liquid-borne particles, the calibration of laser and electron microprobe instrumentation, nuclear activation analysis, and for mass spectrometric analysis.

For example, in electron probe microanalysis, it is generally assumed that a good specimen should be perfectly flat, of semi-infinite dimensions, and should not contain organic material. Unfortunately, biological material does not comply with these requisites; yet, the potentialities of electron probe microanalysis of biological material are very great. Therefore, an attempt must be made to establish experimental conditions for biological microanalysis by means of standard reference materials that are similar in nature to biological materials, and at the same time are well characterized with reference to composition and homogeneity. The ion exchange microstandards are an important step in this direction; it can therefore be expected that they will be of great usefulness in the exploration of chemical structures within very small sections of biological material.

Investigators requiring ion exchange beads loaded with elements or mixtures not presently available as NBS Standard Reference Materials are invited to direct inquiries to the NBS Office of Standard Reference Materials.[2]

[1] For further details, see Freeman, D. H., Currie, L. A., Kuehner, E. C., Dixon, H. D., and Paulson, R. A., **Development and Characterization of Ion Exchange Bead Microstandards**, Anal. Chem. **42** (2) 203–209 (Feb. 1970).

[2] These standards may be obtained from the NBS Office of Standard Reference Materials, Rm. B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20234.

NOTES

In the fall of 1965 the Secretary of Commerce established the NBS Center for Computer Sciences and Technology to carry out the Secretary's responsibilities under the Brooks Bill (Public Law 89–306, passed October 30, 1965). The Center, under the direction of H. R. J. Grosch, provides leadership and coordination for government efforts in the development of voluntary commercial information processing standards, develops recommendations for Federal information processing standards, performs required research and analysis, and provides scientific and technical support and consultative assistance in the field of computers and information processing to Federal agencies. These Notes will cover information-processing standards activities in the Federal Government, particularly those of the Center.

VOLUNTARY NATIONAL STANDARDS FOR COMPUTERS AND INFORMATION PROCESSING

The development of standards is an activity on which the national economy depends. To industry, standardization provides dollar savings through mass production, production of uniform goods, and reduction of time and materials through standard designs, equipment, procedures, and testing. To the purchasing agent, standards offer increased efficiency by freeing him from preparing individual sketches, descriptions, and specifications for each purchase. The distributor benefits from having to stock fewer varieties and sizes of commodities and from simplified inventories. Every branch of industry and commerce recognizes that standards promote fair trade by providing a common language between buyer and seller and a basis for evaluating competitive vendors.[1]

The above statements are directed at standards in general, but are most pertinent to computers and information processing. As the computer industry grows to maturity, standardization is becoming a more essential factor. Early emphasis during the growth of the industry was in getting each component of a system to work. Now that this has been attained, entire systems must be made to work together. For this, standards must be considered in the initial design of data systems, rather than after they are built.

Today the industry is paying for its earlier neglect of standards by expending untold resources (time, money, and manpower) to build a multitude of black boxes (hardware and software) to provide the interfaces between systems and components. An estimated 25 percent of the present computer power is used to provide systems compatibility. In fact, entire new industries have been established to provide conversion services. Because this situation had reached such tremendous proportions, a committee was formed in 1960 to address this national problem under the auspices of the now American National Standards Institute (formerly the American Standards Association and, from 1966 to 1969, the United States of America Standards Institute). This committee, which was named the USA Standards Committee for Computers and Information Processing with the committee designation X3, was given the task of standardization related to systems, computers, equipments, devices and media for information processing systems.

The Federal Government is a major contributor to the work of the American National Standards Institute (ANSI). The Director of the National Bureau of Standards is a member of its Board of Directors. Representatives from various Government departments and agencies participate through the many ANSI councils, boards, committees, subcommittees, and task groups.

Soon after the NBS Center for Computer Sciences and Technology was formed in 1965 and given the responsibility for Federal standardization in this area, the Bureau of the Budget provided policy direction by stating that NBS would participate on and cooperate in the development of national voluntary standards to the extent that such activities were beneficial to the Federal Government. Also, NBS was given the responsibility of monitoring the participation of Government representatives on the different ANSI standardization groups to ensure that the interests of the entire Federal establishment were presented and protected in the field of information processing. The NBS Office of Information Processing Standards was established within the Center to handle this task.

In developing standards for use in the Federal Government that provide economic and effective use of computers and related systems, major emphasis is given to the development and adoption of national voluntary standards that also meet the needs of Federal activities. Developing separate Federal standards would be much faster and

simpler than spending months or, in some cases, years in contributing to the development of national voluntary standards. However, separate and different Federal standards eventually cost the Government more in that they lead to tailor-made or customized equipment and services of use only to Government. Not only must the Government guard its interests, but it must also be aware of the industry's need for standards and the role of standardization in promoting international trade and commerce. (The international aspect of computer standardization was the subject of a recent article in FIPS Notes, *NBS Technical News Bulletin*, February 1970.)

Because of the Government's concern with ANSI's role in standardization, some basic information about ANSI is pertinent.

ANSI is the national clearinghouse and coordinating agency for voluntary standards in the United States. It is a nonprofit (membership) organization incorporated under the laws of the State of New York and is located at 1430 Broadway in New York City. It is a federation of approximately 140 trade associations and professional societies, and over 750 companies, which are dues paying members. Donald L. Peyton is the Managing Director of the Institute.

ANSI was originally organized as the American Engineering Standards Committee (AESC) in 1918 by five engineering societies: American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers, American Society of Mining and Metallurgical Engineers, and American Society for Testing Materials. The AESC's initial purpose was to provide means for coordinating the standards issued by its founders, eliminating confusion and duplication among those standards. Its first act was to invite three Federal Government departments to join and work with the founding societies; the War Department, the Navy Department, and the Department of Commerce accepted the invitation. Enlarged in 1920 by the addition of trade associations, as well as more technical and professional societies, the AESC in 1928 was reorganized as the American Standards Association (ASA) to provide a more workable structure. The principles and procedures that were developed by the founders basically applied to the work of the American Standards Association through 1966, when ASA became the United States of America Standards Institute (USASI). In 1969, the present name, American National Standards Institute, was adopted.

As the national clearinghouse for standards, ANSI provides the machinery for developing and approving standards that are supported by a national consensus. Its constitution states: "In standardization practice a concensus is achieved when substantial agreement is reached by concerned interests according to the judgment of a duly appointed authority. Consensus implies much more than the concept of a simple majority, but not necessarily unanimity."

Technical societies, trade associations, consumer groups, and the like make up the Member Bodies of ANSI. Other classes of members are Company Members, Sustaining Members (individuals or organizations not otherwise eligible for membership but interested in standards development), and Honorary Members. Three councils make up the operating arms of ANSI—the Member Body Council, the Company Member Council, and the Consumer Council. Each council may establish such boards and committees as are considered necessary to accomplish its program. The Member Body Council is responsible for approving standards, and develops and maintains all procedures relating to the preparation, approval, acceptance, and designation of standards, and the constitution of standards boards and committees. The Company Member Council develops programs to maintain liaison with, and represent the interests of, commerce and industry in ANSI's work. The Consumer Council is responsible for the representation and protection of consumer interest in ANSI's work. The Consumer Council is also concerned with the application of ANSI's procedures for certifying and labeling consumer goods. Both the Company Member Council and the Consumer Council may recommend standards projects to be developed.

The Board of Directors is ANSI's governing body. It may delegate any part of its authority over the conduct of ANSI's affairs. Of the 45 members of the Board, 16 are drawn from the Member Body Council, 12 are nominated by the Company Member Council, four are nominated by the Consumer Council, and four are directors-at-large nominated by the Board of Directors. In addition, the president, the three vice presidents, the Director of the National Bureau of Standards, if willing to serve (ex officio, with vote), the chairman of the three councils, and the past president of ANSI are members of the Board.

Over 2800 American National Standards have been published. Of these, more than one-third were submitted by competent organizations that had developed standards through their own procedures, and supplied evidence of consensus in support of such standards. The balance resulted from the work of sectional committees.

ANSI is the United States Member Body of the International Organization of Standardization (ISO). The United States' viewpoints to be presented in the technical work of the ISO may be developed through the interested ANSI sectional committee, through a competent committee of another standards organization, or through a committee specifically organized as an Advisory Committee to an ISO Technical Committee. The work of the Technical Committees eventually results in ISO Recommendations that may be embodied in the national standards of the ISO Member Bodies. A number of ISO Recommendations have been embodied in American National Standards. For international standardization in the electrical field, ANSI provides services to the United States National Committee

of the International Electrotechnical Commission (IEC). The IEC, an autonomous (non-governmental) organization formed in 1904, serves as the electrical branch of the ISO and devotes its activities solely to the electrical field.

Financial support for ANSI comes from dues paid by Company Members, Member Bodies, and Sustaining Members. An additional source of income comes from the sale of American National Standards. In addition to the annual catalog of American National Standards, ANSI publishes quarterly the *Magazine of Standards*, which is devoted to the discussion of principles, practice, and application of standardization, as well as news of ANSI and international standards activities.

Annually, ANSI holds a National Conference on Standards that includes presentation of standards problems at the international, national, industry, and company level. The proceedings of these conferences are published and are available to the public.

To provide direct supervision of the hundreds of ANSI technical activities, there exists within ANSI a number of standards boards, each responsible for several efforts in a particular area of standardization.* One such board is the Information Processing Systems Standards Board (IPSSB). ANSI Committee X3, along with the standards committees for Office Machines, Vocabulary for Automatic Control, and Library Sciences and Documentation, report to IPSSB. The IPSSB is responsible for all aspects of standardization of systems that transmit, store, or process analog symbolic or encoded representations of information, including satellite or control systems, peripheral equipment, and auxiliary devices that significantly influence the effective utilization of composite information processing systems. H. R. J. Grosch, Director of the NBS Center for Computer Sciences and Technology, and George W. Dodson, Assistant Commissioner for Automated Data Management Services, General Services Administration, are Government members of the IPSSB.

CURRENT X3 COMMITTEE ACTIVITIES

At a meeting held in October 1969, American National Standards Committee X3, Computers and Information Processing, approved the publication of an American National Information Processing Dictionary and the submission of two revised American National Standards to ANSI for approval.

The American National Information Processing Dictionary will eventually replace American National Standard Vocabulary for Information Processing, X3.12–1966, and will serve as a set of guidelines for the information processing community.

The two revised standards submitted to ANSI for approval are American National Standard X3.2–1963, Print Specifications for Magnetic Ink Character Recognition, and ANSI X3.3–1963, Bank Check Specification for Magnetic Ink Character Recognition.

The X3 Standards Planning and Requirements Committee reported it had authorized two ad hoc committees to begin prestandardization work on magnetic tape cassettes and display parameters.

BEMA TO HAVE NEW STANDARDS DIRECTOR

Effective April 1, 1970, Vico E. Henriques will join the Business Equipment Manufacturers Association (BEMA) as Director of Standards. Mr. Henriques will head a new Standards Department which will report directly to the Office of the President of BEMA. This department will provide the administrative support and direction for the American National Standards Institute Committees X3, Computers and Information Processing, and X4, Office Machines, for which BEMA holds the Secretariats. The counterpart international standards programs of ISO TC/97, Computers and Information Processing, and ISO TC/95, Office Machines, will also be supported by the new department. Heretofore, such support has been provided separately by BEMA's Data Processing Group (DPG) and the Office Machines Group (OMG). DPG and OMG will continue to provide policy direction, technical guidance, and financial support to the BEMA Standards Department within their respective areas of interest.

Prior to joining BEMA, Mr. Henriques was a director of Arthur Young and Company. He formerly was associated with BEMA as DPG Director of Standards from January 1963 to April 1966, and was also with the National Bureau of Standards where his experience ranged from operations research to the development of automatic data processing standards.

*As this goes to press, the series of ANSI Standards Boards is being replaced by a Board of Standards Review, which will pass on all standards, and a series of Technical Advisory Boards specialized in particular subject matter. This will affect the name and responsibiltes of the Informaton Processing Systems Standards Board (IPSSB).

[1] For further details, see Hartman, J. E., **Directory of United States Standardization Activities**, Nat. Bur. Stand. (U.S.), Misc. Publ. 288 (Aug. 1967). Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for $2. Order by SD Catalog No. C13.10:288.

ACCELEROMETERS *continued*

base and vibrating structure greater than that of the seismic mass to the accelerometer base.

The engineer should find most helpful Mr. Newman's parameter values in table 1, for which the resonant frequency values obtained by the two methods differ by 2 percent. Most users will find this level of discrepancy tolerable. Also given are parameter sets for which the difference between the resonant frequencies is 10 percent.

[1] For details, see Newman, Nathan, **Considerations in Computing the Useful Frequency Range of Piezoelectric Accelerometers**, Nat. Bur. Stand. (U.S.), Tech. Note 487 (July 1969), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 30 cents. Order by SD Catalog No. C13.46:487.

CONVERSION OF THERMODYNAMIC PROPERTIES FROM IPTS 48 TO 68

The International Practical Temperature Scale of 1968 [1] was adopted as a replacement for the corresponding 1948 scale because it more closely approximates the thermodynamic temperature scale and extends the defined temperature scale downward from a previous 90 K to 14 K (approximately).

This brings up a situation in which many existing tables of thermodynamic functions (enthalpy, heat capacity, entropy, and free energy at various values of temperature) have been generated on temperature scales less representative of the thermodynamic scale than is now possible. A need exists, therefore, at least in some cases, to convert these data to the IPTS–68 scale.

To meet this need, T. B. Douglas of the NBS Institute for Basic Standards has derived formulas [2] for converting thermodynamic values from the 1948 to 1968 scale at the same numerical value of temperature on both scales. The formulas, in the form of exact infinite series, can be used to convert from any continuous temperature scale, such as those defined as varying linearly with thermometer resistance, thermocouple electromotive force, or brightness temperature shown by a specific instrument. Very simple approximations of these formulas are usually adequate for conversion from the IPTS–48 to the IPTS–68, even in many cases where the calorimetry was highly accurate.

In addition, equations were derived giving the numerical differences between these two temperature scales from 90 to 10 000 K. Some of these equations are similar to ones that have been derived elsewhere.[3]

[1] The International Practical Temperature Scale of 1968, Metrologia 5, 35–44 (April 1969).

[2] For complete details, see Douglas, T. B., Conversion of Existing Calorimetrically Determined Thermodynamic Properties to the Basis of the International Practical Temperature Scale of 1968, J. Res. Nat. Bur. Stand. (U.S.), 73A, 451–470 (Sept.–Oct. 1969).

[3] Bedford, R. E., and Kirby, C. G. M., Notes on the application of the International Practical Temperature Scale of 1968, Metrologia 5, 83–87 (July 1969).

STANDARDS AND CALIBRATION

WWV: CHANGE IN ISSUE TIMES OF PROPAGATION FORECASTS

WWV broadcasts a forecast of radio propagation conditions in International Morse code during the last half of every fifth minute of each hour on each of the standard frequencies. These forecasts refer to propagation paths in the North Atlantic Area, and are prepared by the ESSA Telecommunication Services Center (Boulder, Colo.).

On March 1, 1970, the regular times of issue of the four daily propagation forecasts were changed. The new times of issue are 0200, 0800, 1400, and 2000 UT for the period November 1 through April 30, and 0100, 0700, 1300, and 1900 UT for the period May 1 through October 31. Previously, the issue times were 0500, 1100 (1200 from November 1 through April 30), 1700, and 2300 UT.

These new issue times do not affect the time of broadcast from radio station WWV. The number, quality, reliability, and format of each forecast remains the same.

STANDARD FREQUENCY AND TIME BROADCASTS

High-frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. These NBS time signals, UTC (NBS), are maintained within 5 microseconds of the corresponding time signals of the U.S. Naval Observatory, UTC(USNO). The UTC pulses occur at intervals that are longer than one coordinate second by 300 parts in 10^{10} during 1970, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on May 1, 1970.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be no adjustment made on May 1, 1970.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

CONFERENCE & PUBLICATION *Briefs*

LASER POWER AND ENERGY MEASUREMENTS SEMINAR

The second of a series of seminars on the techniques used at the Bureau to measure laser power and energy was held December 4–5, 1969, at the Boulder (Colo.) Laboratories. About 30 participants from industry, government, and military laboratories attended the lectures and discussions. The topics included calorimeter problems, measurements of power and energy from repetitively pulsed, CW, and CO_2 lasers, and the analysis of errors. A substantial amount of time was devoted to a discussion of health and safety considerations, a topic not covered in the first seminar. On the second day of the seminar there were informal visits to the laser labs of the NBS facility, and discussions between participants and laboratory personnel.

The health and safety issue was raised by David Sliney of the Laser Microwave Division, U.S. Army Environmental Hygiene Agency. He outlined the problems of defining what combination of power density and wavelength constitutes a dangerous laser beam. Such definition is especially difficult because of the present lack of documented data on tissue damage. He noted that at visible wavelengths damage can be caused by power densities of the order of that received from the sun, a level exceeded easily by most present-day lasers. But he also pointed out that there is nothing extraordinary about laser radiation, aside from its collimation or narrow beam, to cause a unique sort of injury. Other extremely bright sources of light, such as arc welders, may produce eye damage similar to laser damage. The laser's beam, however, may be transmitted over much longer distances and still be dangerous, because the beam does not spread as much as the rays from an arc welder's flame.

Henry Rechen of the Bureau of Radiological Health (B.R.H.), in another presentation on the same subject, told of the lack of regulations in the laser field. He gave as examples the $100 laser for school use that produces 30 mW of CW power, and a $400 home holography movie viewer being readied for the market. Both would have many times the power needed to blind the incautious user, and the former, at least, is sold to anyone without regard to training.

Dr. H. F. Stewart, Chief of Electronic Products Studies, Southwestern Radiological Health Laboratory (SWRHL), B.R.H., said "The B.R.H., under the Public Health Service, is charged with administering the new Radiation Control Act (P.L. 90–602) passed by Congress this session. But until standards for damage thresholds, shielding, etc., can be set, the law is not a strict regulator of activities or equipment." These standards are being investigated and evaluated at the SWRHL in Las Vegas; R. W. Peterson, of that laboratory, described some of the work they are doing to build instruments to measure laser output and establish standards.

The technical discussions of laser power and energy measurements were based upon *Laser Power and Energy Measurements*, NBS Tech. Note 382 [1] (64 pages, 65 cents; SD Catalog No. C13.46:382).

SCHEDULED NBS-SPONSORED CONFERENCES

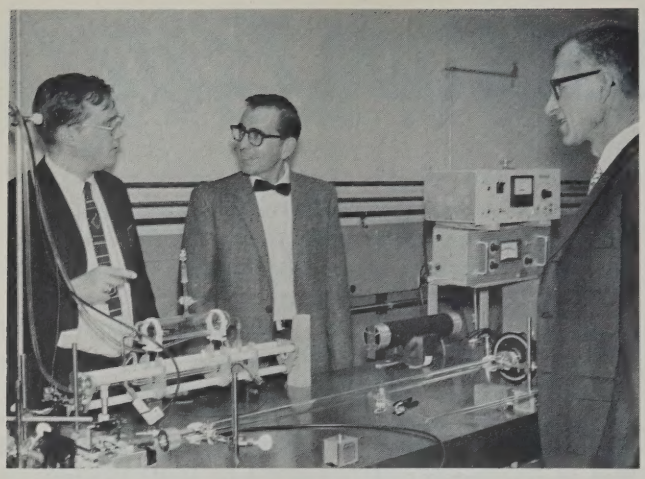
Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

Second IEEE Transducer Conference. May 4–5. Sponsor: IEEE (Group on Industrial Electronics and Controlled Instrumentation). Contact: Paul Lederer (NBS Electronic Technology Division).

Operations Research—Users and Producers. May 7–8. Cosponsors: Institute of Management Sciences; Operations Research Society of America; Washington Operations Research Council. Contact: Lloyd Burden (NBS Technical Analysis Division).

Silicon Device Processing. June 2–3. Cosponsor: American Society for Testing and Materials (Committee F–1). Contact: C. P. Marsden (NBS Electronic Technology Division).

1970 Conference on Precision Electromagnetic Measurements. June 2–5. Cosponsors: IEEE (Group on Instrumentation and Measurement); International Scientific Radio Union (U.S. Commission 1). Contact: George Goulette, Bureau of Continuation Education,



David Sliney (Army Environmental Hygiene Agency, left), George Leavitt (Lawrence Radiation Laboratory, center), and E. D. West (NBS) discuss an infrared laser at the Boulder Laboratories.

University of Colorado, Boulder, Colo. 80302. To be held at NBS in Boulder, Colo.

1970 Standards Laboratory Conference. Innovative Metrology—Key to Progress. June 15–17. Sponsor: National Conference of Standards Laboratories. Contact: H. L. Mason (NBS Institute for Basic Standards).

55th National Conference on Weights and Measures. July 12–17. Contact: H. F. Wollin (NBS Office of Weights and Measures). To be held at the Hotel Utah, Salt Lake City, Utah.

International Conference on Precision Measurement and Fundamental Constants. Aug. 3–7. Cosponsors: IUPAC; CODATA; National Academy of Sciences-National Research Council; International Bureau of Weights and Measures. Contact: E. Ambler (NBS Institute for Basic Standards).

Space Simulation Conference. Sept. 14–16. Cosponsors: American Institute of Aeronautics and Astronautics; Institute of Environmental Sciences; American Society for Testing and Materials. Contact: J. C. Richmond (NBS Heat Division).

National Conference on Metrication. Sept. 21–25, Oct. 12–16, and Nov. 16–20. Contact: J. Odom (NBS Office of Invention and Innovation). To be held at Department of Commerce Auditorium, Washington, D.C.

25th Calorimetry Conference. Oct. 19–22. Contact: E. Domalski (NBS Physical Chemistry Division).

The Science of Ceramic Machining and Surface Finishing. Nov. 2–4. Cosponsors: Office of Naval Research; American Ceramic Society. Contact: S. J. Schneider (NBS Inorganic Materials Division).

Symposium on the Application of Computers to Environmental Engineering Design. Nov. 30–Dec. 2. Cosponsor: American Society of Heating, Refrigerating and Air Conditioning Engineers. Contact: R. Achenbach (NBS Building Research Division).

NATURAL WEATHERING OF ROOFING SPECIMENS

Natural Weathering of Mineral Stabilized Asphalt Coatings on Organic Felt, by Sidney H. Greenfeld, NBS Building Science Series 24[1] (30 cents, SD Catalog No. C13.29/2:24), is a progress report on the first 17 years of outdoor weathering tests on laboratory-prepared smooth-surface and mineral-surfaced felt-base roofing specimens. The tests were performed to provide information on the effects of mineral additives on the durability of coating-grade roofing asphalts. Six finely divided mineral additives (blue-black slate, clay, dolomite, fly ash, mica, and silica) were evaluated at concentrations up to 60 percent in California, Mid-Continent, and Venezuela asphalts. The mineral-surfaced specimens are all performing satisfactorily, and show only minor degrees of degradation. The mica and blue-black slate increased the durabilities of all three asphalts at all concentrations. Fly ash, clay, dolomite, and silica were beneficial in some combinations, but had little effect in others. Of the smooth-surfaced specimens, those made with the Mid-Continent asphalt have performed the best and those with the California asphalt the poorest. In general, these outdoor exposures tend to corroborate the results obtained when the same coatings were exposed in weatherometers.

ION-SELECTIVE ELECTRODES SYMPOSIUM PROCEEDINGS

Ion-Selective Electrodes, Special Publication 314[1] ($3.50; SD Catalog No. C13.10:314), is the proceedings of a symposium sponsored by the NBS Analytical Chemistry Division, January 30-31, 1969. The Symposium speakers surveyed and evaluated recent advances in the theory, development, and application of non-glass ion-selective electrodes. They also reviewed the "state of the art" of these new electrochemical sensors.

Edited by R. A. Durst, the volume consists of the texts of the eleven invited lectures, including material not presented at the symposium, and selected segments of the discussion sessions. The authors discuss various aspects of the present and future capabilities of these electrodes, emphasizing the applications and methodology in a wide range of scientific disciplines. As presented, the topics provide as broad a coverage of the interdisciplinary aspects of these electrodes as is feasible at this stage of their development. The applications include use of the electrodes in the thermodynamic, kinetic, and complex-ion studies; pure and applied research in various biomedical areas; industrial analysis and control systems; and applications to diverse analytical problems. Extensive bibliographies provide an excellent survey of the literature on these electrodes.

[1] Order by SD Catalog number from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

U.S. GOVERNMENT PRINTING OFFICE: 1970 O—376-793

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin. Annual Subscription: Domestic, $3; foreign, $4. Single copy price 30 cents. Available on a 1-, 2-, or 3-year subscription basis. SD Catalog No. C13.13:54.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $9.50; foreign, $11.75. Single copy price varies. SD Catalog No. C13.22/sec.A:74.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.B:74.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.C:74.

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U.S. Government Research & Development Reports. Semimonthly journal of abstracts of R&D reports on U.S. Government-sponsored projects and U.S. Government-sponsored translations of foreign technical material. Annual subscription (24 issues): Domestic, $30; foreign, $37.50. Single copy, $3.

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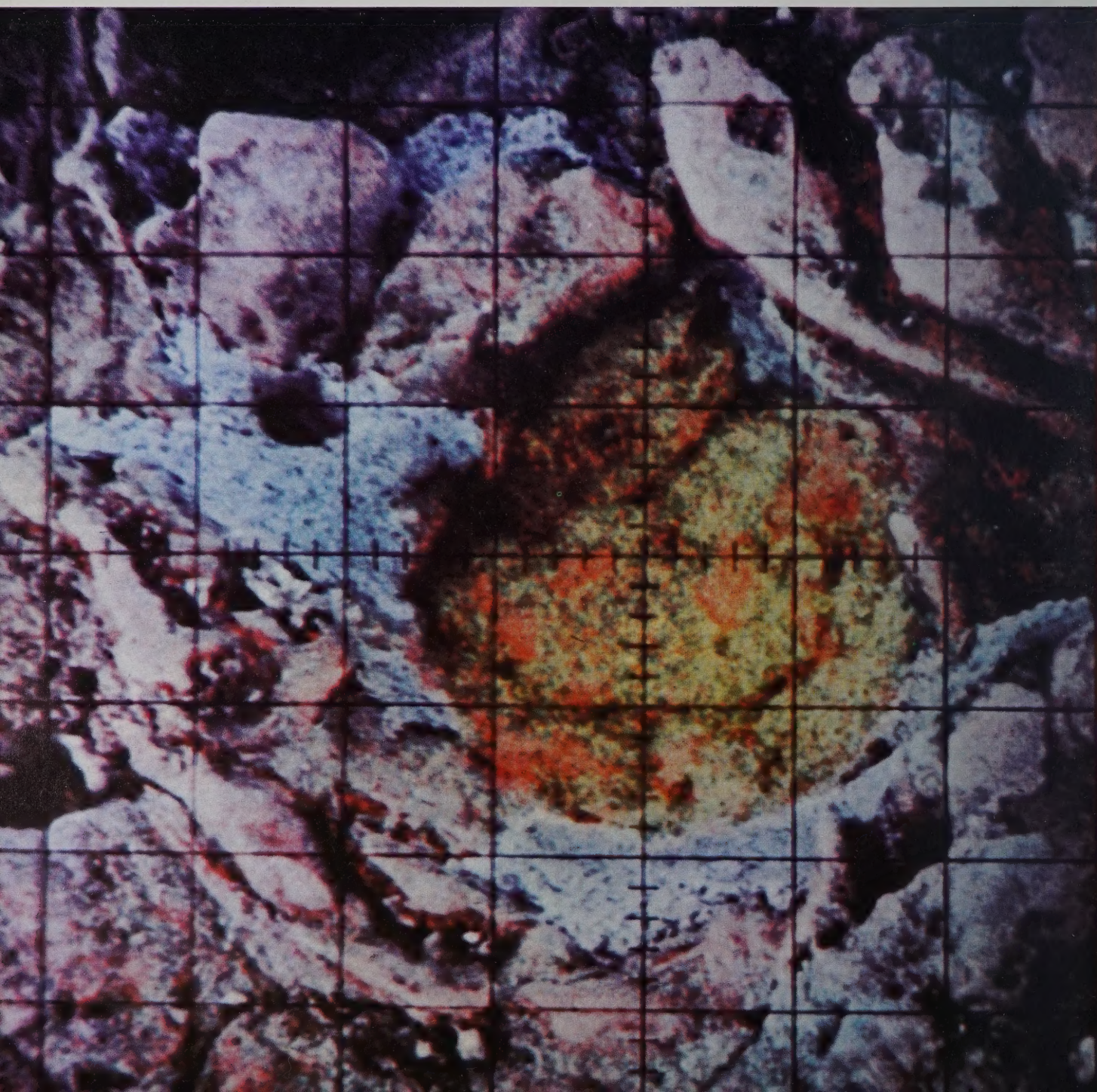
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